

Whittlesey - Geology of Columbiana, Stark and Tuscarawas
Counties.

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GENERAL GEOLOGY OF THE COUNTIES OF COLUMBIANA,
STARK, AND TUSCARAWAS.

BY COL. CHAS. WHITTLESEY.

STRATA BELOW THE CO'L.

Until it is definitely settled what is Portage and Chemung in Pennsylvania, to the Ohio line, those terms cannot be used with much certainty in this State.

The paleontologists have lowered the line of the carboniferous here, until it lies below both of them.

Stratigraphically, the following arrangement seems to me the nearest approach to a solution :

First.—Beneath the coal a “*conglomerate group*,” embracing the pebbly sand rock, the shales, and the Berea grit, which frequently has pebbles of quartz. Going southerly these graduate into the Logan of Professor Andrews, and include the Maxville limestone, all of which are irregular, but belong to the sub-carboniferous series.

Second.—The “*Waverly Group*,” embracing the flags and shales below the Berea grit, to the black or Huron shale. This is characterized by sandstone layers of a finer grain; a greenish-yellow color, and occasional pebbles, rapidly passing into olive or light-green shales, with thin plates of iron ore and ferruginous sandstone. The local subdivisions of these two groups, from the Lake to the Ohio River, yet remain to be worked up.

We must keep constantly in mind the distinction between the general dip of the strata and their local irregularities.

Locally they all present curved and warped surfaces; producing basins, troughs, mounds, and ridges, of no regular pattern.

Taking the lowest places in these basins, representing the sumps and swamps of the mines, over large spaces; the elevations of such points show an inclination quite regular as to direction, but differing materially as to the amount or rate of inclination. Whenever we fix the elevation of three such points, we have a plane of dip for the space represented. Until this is done, there is ample room for mistakes in the identification of strata. Any survey where these data are neglected will soon require

rectification. It is much easier to arrange them conjecturally, but quite unsafe. It would be reasonable to conclude that the upheavals of the Alleghany mountain chains, which occurred after the carboniferous epoch, would produce undulations, folds, or disturbances in the Ohio coal strata, but a close examination does not sustain such an hypothesis. The irregularities visible in these beds appear to be due to currents of deposition, which swept about in channels and eddies, producing ridges and hollows on the ancient bottom, as the ocean waters do now.

Beds of sandstone and shale are the most irregular of the series. Those of limestone, iron ore, and coal, are more persistent, because their deposit is due not only to mechanical sediments, but to chemical attraction and segregation. The shales and the sandstones are almost without chemical affinities, and were deposited by currents, with a variable force, acting without system. The mineral substances with which the carboniferous seas were charged, sank in comparatively quiet and muddy waters, and therefore with more regularity than the earthy matters; but in neither case with perfect uniformity. Theoretically the thin mineral strata should be, and in fact are, about equally persistent; but it is not safe to assume that any of them are identical with other beds of the same mineralogical character, until the connection is made out by close examination in the field.

We have now all the facts we are likely to have for many years to come, relating to the physical geology of Ohio. Whoever looks through the reports on economical geology, in the coal-producing counties of the north-eastern district, will be unable to reach satisfactory conclusions.

A comparison of the profiles and of the text, where it relates to stratigraphy, will show numerous contradictions.

For the purpose of testing the theory of the persistence of *Coal Seam No. 6*, and of the *Putnam Hill limestone*, I have made a comparison of the vertical sections over a large part of the region. I give, in the form of skeleton profiles, the results of this comparison. To do this fairly, I assume, with the reports, that No. 6 is persistent, and use it as an horizon, bringing the other coal and limestone beds into their physical relations on that theory.

I think this comparison, thoroughly carried out, would show that No. 6 and the Putnam Hill limestone cannot both be persistent. If one is, the other is not.

After studying this subject since 1837, doing, I believe, as much field work as any other geologist has bestowed upon it, I am not able to say that any one of the coal seams of the lower series is continuous. At least it has not been demonstrated to be so, by exact physical profiles. Between

the typical No. 6 coal, in the valley of the Tuscarawas and that of the valley of Little Beaver, facts are lacking to demonstrate their identity.

The Yellow Creek series is connected with these two valleys, as yet, only by a plausible hypothesis. From Zoar down the Tuscarawas to Coshocton, at the confluence of that stream with the Walhonding, forming the Muskingum, Nos. 5 and 6 are in place, though in several places the elevation is fifty to sixty feet too low. From the southerly part of Coshocton county to the middle of Muskingum and Licking, the connection of No. 6. with the upper New Lexington seam is yet to be proven.

To make these comparisons I am obliged to use a very small scale of profile, and to be content with only a few sections. A large part of them are taken from the official reports. Groups Nos. 1, 2, and 3 follow in regular order, from the State line, through Columbiana, Stark, Carroll, and Tuscarawas counties, to Muskingum. If put together, end to end, they would form a profile of the beds of limestone and coal, for the lower coal series, half way across the State.

Figure No. 1 shows, everywhere in Columbiana county, No. 3 limestone not far below No. 6 coal.

Figure No. 2, sections *a* and *b*, in Carroll county, show No. 5 coal to have a limestone roof, which, possibly, represents the white lime-rock of Columbiana. The other official sections, *c, d, e, f, h, i*, do not show it. Between the Zoar section, *Figure No. 2, f*, which is typical for No. 6 coal, and the Zanesville section, *Figure No. 3, g*, typical for the "Putnam Hill limestone," there is represented a space of about fifty miles, in a direct line. The local sections of the reports for this space show, in places, two, three, and four beds of limestone beneath Nos. 5 and 6 coal. Probably a thorough exploration would bring out three seams over most of this space. Beginning at Navarre, in Stark county, Nos. 1, 2, and 3 are found in regular order, on both sides of the river; also at the forks of Sugar Creek, and thence, wherever the valleys are deep enough for them, over the summit, southerly, towards Coshocton, full half way to Zanesville.

I insert below a tabulated list of elevations at points where the three beds of lime-rock are found in the same hill.

FIGURE 1.—GROUPED SECTIONS, COLUMBIANA COUNTY, OHIO.
 (Vertical scale $\frac{1}{4}$ inch to 100 feet; 530'A. elevation above Lake Erie.)

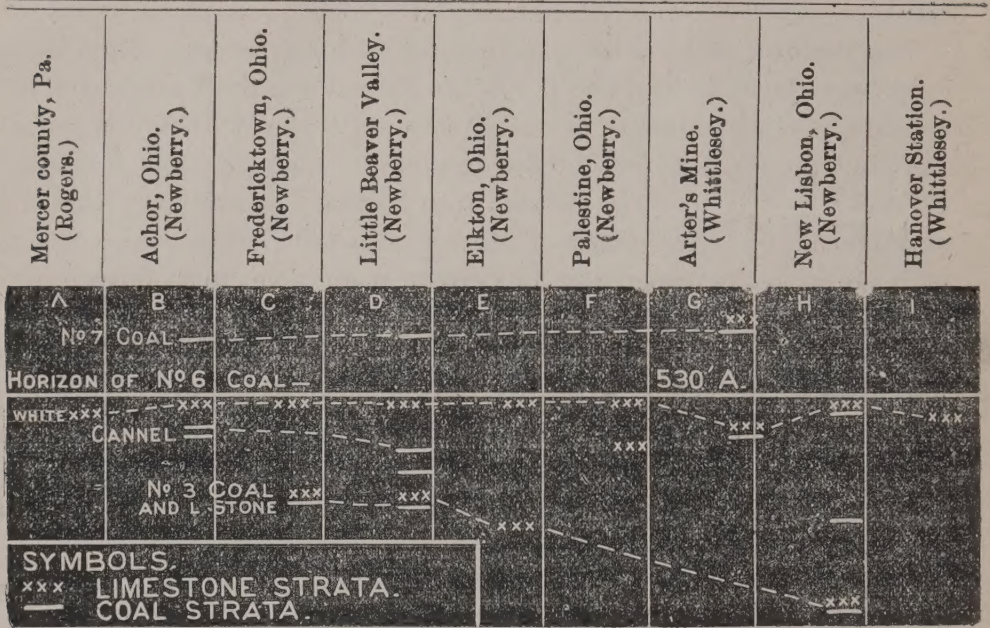
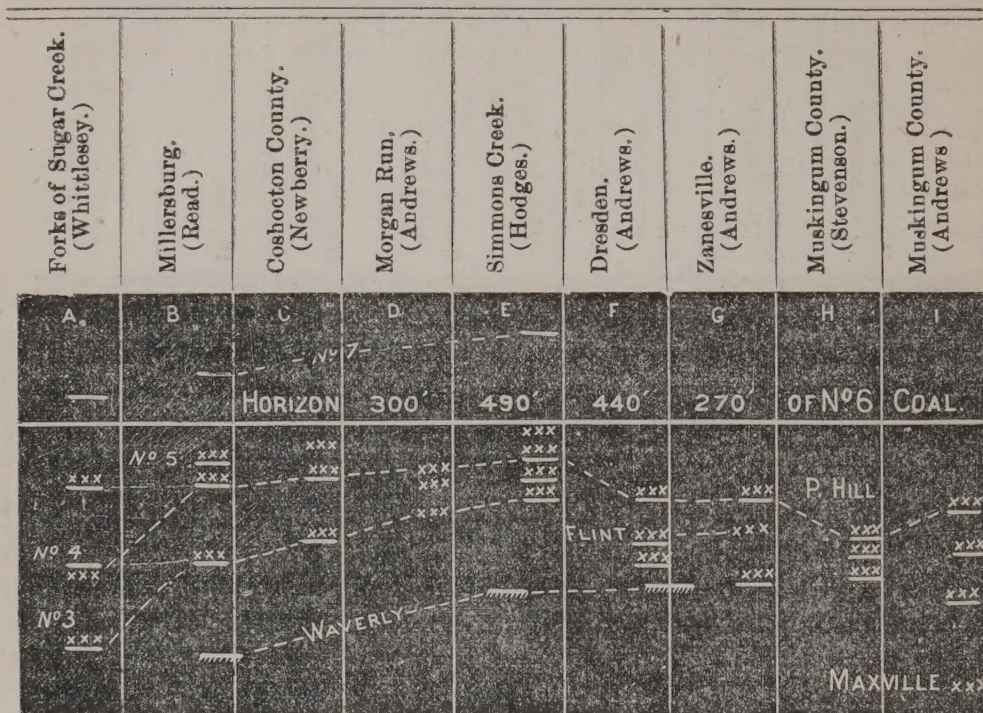


FIGURE 3.—GROUPED SECTIONS, TUSCARAWAS, COSHOCTON, AND MUSKINGUM.

(Scale and symbols same as in No. 1.)



This upper bed, or No. 3, not having entered into the official observations, the premises being false, the conclusions must of necessity be wrong. The question arises, to which of the three beds on Sugar Creek shall the typical Putnam Hill limestone be attached? Is it the equivalent of any of them? The connections I have made, by dotted lines in Figure No. 3, are not to be regarded as conclusive; they are simply official. It is much more probable that it should be connected with No. 3 limestone.

No. 2, or the "gray limestone," cannot be forced into the position of the Putnam Hill in the present state of information.

If the gray limestone of Tuscarawas could be shown to be the same as Prof. Andrews' typical Putnam Hill, this chasm would be bridged over. As yet only a few of the timbers are set up, and at points not in close relation to each other.

The Upper New Lexington seam, at Zanesville, assumed to be No. 6, is continuous to the Hocking Valley at Nelsonville, where it passes beneath the highlands that continue to the Ohio River. In this space, the number and the equivalency of the beds has been a subject of much discussion. As Prof. Andrews has devoted more time to this field than any other geologist, and his local sections are more numerous than all others, it is reasonable that we give most weight to his opinions.

By reference to Figure No. 4, the position of the three limestones will be understood, over a space of forty miles. All of the regular beds have coal under them, which is not represented on account of the small scale I am obliged to adopt. All of them have bunches and layers of flint, which sometimes extend to the entire thickness of the stratum. As groups, the three limestones and the three coals above them, Nos. 5, 6, and 7, are quite regular. Coals over limestones, so far as I have observed, have shale beneath, never resting upon the lime-rock, while coal seams underneath the lime-rock are without this intervening shale—the limestone forming the roof.

For the Sugar Creek Valley, the following arrangement fits better with the official nomenclature, than any other which I can devise on present information :

FIRST—COAL.

At the base of the series, Coal No. 1, beneath the shale underlying the "Massillon sandstone." Immediately beneath this sand rock is an irregular show of coal, of no practical value, known as No. 2.

SECOND—LIMESTONE AND COAL.

Limestone, No. 1, forming the roof of Coal No. 3; the coal often wanting and seldom workable. This limestone is frequently overlaid by iron ore. The place of Coal No. 1 is about one hundred and sixty feet below this limestone.

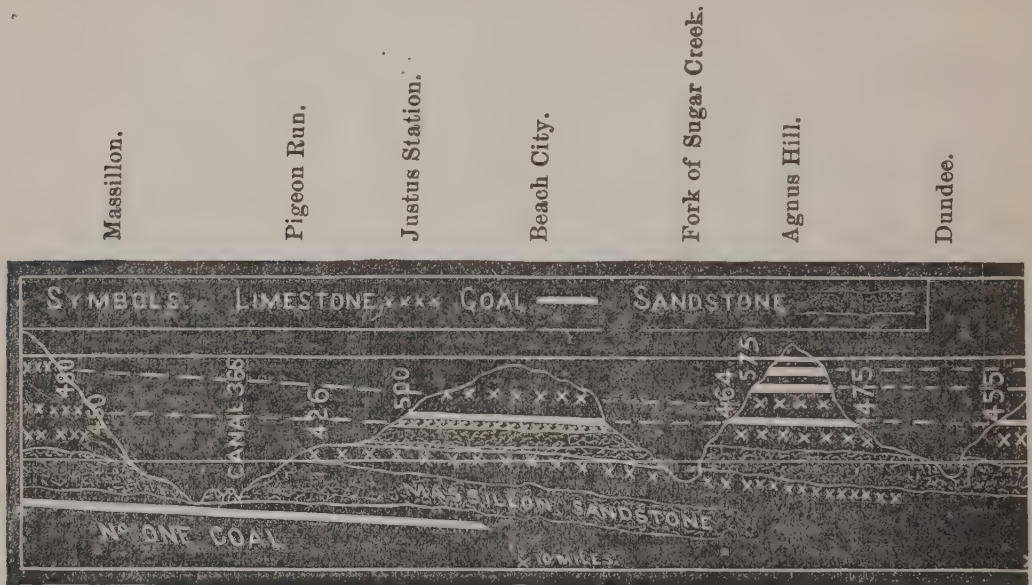
THIRD—SANDSTONE.

The second, or "Deardorff Sandstone," is very irregular in thickness. Beneath it there is occasionally a bed of thin irregular coal, sometimes called No. 3a, and also No. 4. It may be seen at Sheplar's, at Zoar Station, and at the forks of Sugar Creek. Between it and the Massillon Sandstone there is a black or dark colored shale of considerable thickness. In the published profiles, this sandstone is confounded with the Massillon, the top of which is forty to fifty feet below.

FOURTH—LIMESTONE AND COAL.

Limestone No. 2, over Coal No. 4, which is probably not "Putnam Hill." In places there are both coal and fire-clay beneath this limestone. Between Limestone Nos. 2 and 3 there is another bed of sandstone, thirty to eighty feet thick.

FIGURE No. 4.—OUTLINE PROFILE FROM MASSILLON,
 [Distance, 40 miles. Scale, horizontal, 440 miles to an inch



FIFTH—COAL.

A bed of coal, three to four feet thick, ten to thirty feet above the last named stratum of limestone, which is of good quality for general uses, is opened at Fisher's mine, near Justus Station, five hundred feet above Lake Erie, also, near Bolivar, and at Weimars, 488' A, Agnus Hill, 476', Dundee, Barr's Mill, and around Shanesville, near which it passes beneath drainage.

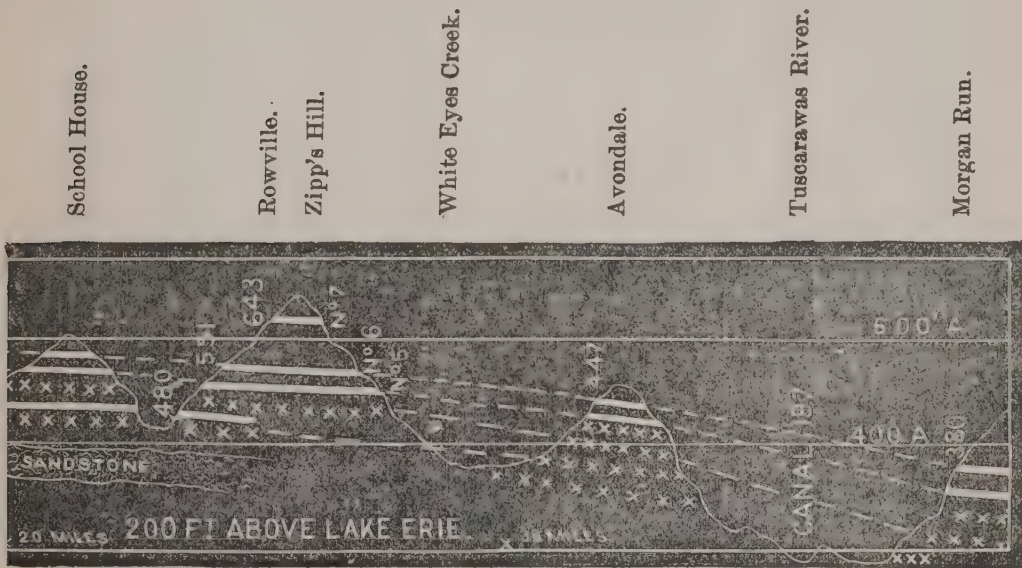
SIXTH—LIMESTONE AND COAL.

Within a vertical interval of seventy-five to ninety feet, Limestone No. 3 comes in, over which in some places is a heavy sand-rock, in others a heavy bed of shale.

This corresponds to the white lime-rock of Columbiana county, and resembles the Putnam Hill, in being the first beneath Coal Nos. 5 and 6. It does not everywhere carry coal beneath it, but as it does in some places, and also fire-clay, in accordance with the Ohio system it should have a place among the numbers. At Avondale, all three of the limestones and their underlying coals are seen, according to Prof. Andrews, in regular order, but compressed into a vertical space of only sixty-eight feet. There is, besides, a bed of flint next below Coal No. 5, and, below all, a sandstone.

THROUGH SUGAR CREEK VALLEY, TO COSHOCTON.

vertical, 400 feet. Elevation in figures.]



SEVENTH—COAL NO. 5.

Generally, within thirty feet of the third limestone, there is a bed of coal corresponding to No. 5 of the reports. It is not everywhere workable; but, within a few feet above it, there is frequently a show of iron ore, often in great force. A heavy bed of dark brownish red shales occupies most of the space from No. 3 Limestone to No. 6 Coal, well charged with ores of iron. This bed is above the Limestone Group. It is an error to place this seam beneath the No. 3 Limestone.

EIGHTH—COAL NO. 6.

Twenty to thirty feet above No. 5 is the most regular and valuable coal of the series in northern Ohio. It ranges from $3\frac{1}{2}$ to $4\frac{1}{2}$ feet in thickness. Generally, after passing a light bed of shale, there is over it a heavy stratum, of irregular thickness, known as the "Mahoning" sandstone.

NINTH—COAL NO. 7.

From ninety to one hundred feet above Coal No. 6, No. 7 comes in, capping the hills, above which is the well-known horizon of *blackband* and *mountain ore*. The coal is of very little value, except for calcining the ore which overlies it. Above it there is, in some places, a lime-roek,

having a blue, buff or white color, but it is not as regular as the lime-rocks lower in the series. The area of this coal is comparatively small. At Sander's Mine, west of the Kilbuck, and at Trenton, on the Tuscarawas, may be seen a blue lime rock between Coal Nos. 6 and 7, which is probably local.

The sections at Zoar, Mineral Point, the tunnel, on the Pittsburgh Branch Railroad, and near Magnolia, are quite diverse, and, therefore, not reliable, as representing a type of the series. The one made with an engineer's level by Mr. Jones and myself, near Navarre, comes much nearer to a typical section.

Since Profile No. 4 was engraved, the railway company has taken additional side levels to the beds of limestone, iron ore, and coal in Sugar Creek Valley. These have disclosed more of the irregularities in the surface and the thickness of the Deardorf sandstone. At Wm. Adams's a mile and a half north of Dundee, its surface is 460' A., with a thickness of about fifty feet. At Graber's old mill, one and one-half miles northwest, it rises to 488' A., with a thickness of about one hundred and eight feet. Four miles southerly, at Barr's Mill, it has sunk to four hundred feet, thickness not seen, and at School-house No. 7, three miles further south, rises to 462'.

The middle limestone conforms in part to these depressions, and in places is cut out by the elevations. At Adams's, it is 472'; at Barr's Mill, 413'; and at Shanesville, 454'. The Fisher Coal does not conform as closely to the sandstone as the lime rock. At Adams's it is about 484', at Barr's Mill about 463', and at Shanesville 458'.

Across the valley, east from Shanesville, on the land of Ben Hochstetler, about twenty-five feet above the Upper Limestone, a fourth lime-rock exists, which extends southerly to within a mile of Rowville, but was not seen on the west side of the valley, and is doubtless local. In places it is eight feet thick, and produces the whitest lime I have seen in the coal series. It is loosely bedded, coming out in thin, rough slabs, of a gray color. Two miles south of the Rowville Summit, I saw a lime-rock about twenty-five feet above Coal No. 6, corresponding to what I have noticed above this seam at Sander's mine, west of the Kilbuck, and at Trenton, on the Tuscarawas, of which I find no mention in the reports. On the west side of Sugar Creek Valley, there is a very great change in the sandstone beds, both above and below Coal Nos. 5 and 6.

These upper coal seams and their shales are the most uniform strata of this region. On the eastern side of the valley, the so-called Mahoning sandstone is slaty, and seldom visible, and in its place are heavy beds of shale.

The typical Putnam Hill Limestone is at Putnam, opposite Zanesville, eighty feet below the Upper New Lexington, Great Seam, or Nelsonville Coal, as it is variously called. Here this lime-rock lies about eighty feet above the channel of the Muskingum River, and one hundred and ninety feet above Lake Erie. Prof. Andrews has traced it northerly up the valley to a point eight miles north of Dresden. The detailed sections made by himself and Mr. Jones at Morgan Run, near Coshocton, do not fix the places of the Putnam Hill Lime-rock, with certainty; nor of the so-called Coal No. 6. Those made by Prof. Newberry in the valley of Simmons's Creek, eight miles west of Coshocton, do not determine its position there, nor do those of Prof. Stevenson and Prof. Read in the valley of the Licking. More physical sections and closer comparisons are necessary to demonstrate the position of the Putnam Hill Limestone in Coshocton county. For the purposes of this paper, I assume that No. 3 Limestone of the Avondale Profiles, made with strict accuracy by Prof. Andrews and Mr. H. D. Dennis, is the Putnam Hill, 384 A. L. E.

As all the profiles show a different number of seams of coal and beds of limestone in different parts of the Ohio Coal Field, it follows, of necessity, that a part of them disappear, or that additional ones come in,

The following abstract proves conclusively that all the beds can not be persistent:

ENUMERATION OF COAL SEAMS AND BEDS OF LIMESTONE IN VARIOUS PARTS OF THE COAL FIELD OF NORTHERN OHIO, REFERRED TO SEAM NO 6.

| Locality. | Number of coal seams. | | | Number of limestone beds. | | | Vertical space, No. 1 to No. 6, coal seams. | Thickness of lower barren measures. | Remarks. |
|--|-----------------------|---------------------------------|--------|---------------------------|---------------------------------|--------|---|-------------------------------------|---|
| | Below No. 6. | Above No. 6 to barren measures. | Total. | Below No. 6. | Above No. 6 to barren measures. | Total. | | | |
| Mercer and Beaver counties, Western Penn. | 12 | 1 | 14 | 3 | 1 | 4 | 600 | 370 | Rogers' Final Report. |
| Columbiana and Mahoning counties, on the Pennsylvania line | 7 | 2 | 10 | 4 | 2 | 6 | 520 | ..... | Ohio Reports. |
| Line of C. & P. Railroad, Ravenna to New Chambersburg, Ohio. | 4 | ..... | ..... | 3 | ..... | ..... | 720 (W.) | ..... | ..... |
| Massillon, Stark county, to Zoar, Tuscarawas county | 6 | 2 | 9 | 2 | ..... | ..... | 374 (N.) | ..... | ..... |
| Yellow Creek, Jefferson county | 5 (N.) | 2 (N.) | 8 (N.) | 2 | ..... | ..... | 310 (W.) | ..... | ..... |
| Valley of Kilbuck, Holmes county | 7 | 5 (W.) | 10 | 2 | 2 | 4 | 310 No. 2 to No. 6 (N.) | 500 | ..... |
| Valley of Black Creek, Holmes county | 4 | ..... | ..... | 2 | 2 | 4 | 250 | ..... | Beds not the same on different sides of the valley. |
| Fredericksburg, Wayne county | 2 | ..... | ..... | 1 | ..... | ..... | 373 | ..... | ..... |
| Simmons's Creek, Coshocton county | 4 | ..... | ..... | 2 | ..... | ..... | 200 | ..... | ..... |
| Muskingum county | 4 | 9 | 14 | 2 | 2 | ..... | 211 | 140 | Prof. E. B. Andrews. |

In the proceedings of the *Boston Natural History Society* for November, 1874, I gave reasons why No. 6 coal in the Coshocton county profiles, may not be the seam having the same number in the Tuscarawas profiles. The final report places their identity in a better light than before, but does not fully settle the question. They can not be brought into harmony upon the theory of undulations, caused by the uplifts of the Alleghanies, for the axes of the undulations lie at all angles with these uplifts, showing that they are merely local troughs, and basins of deposition. Frequently, the lower coal seams were deposited in pre-existing hollows of the Waverly, and thus are limited on all sides by the edges of those local basins. Such circumscribed beds can not be said to be the equivalents of beds in other basins, until the connection is proven by exact physical profiles.

From the Muskingum to the Hocking the identity of seams No. 5 and 6, which form a pair, and lie only twenty-five or thirty feet apart, may be considered as established, the Upper or No. 6 being the Great Seam of Perry county. Beyond this, towards the Ohio River, there is still a discussion between Professor Andrews and other eminent geologists, in regard to the equivalents of the Putnam Hill limestone, and of the No. 6 coal. If it can be established that No. 6 is continuous from the Pennsylvania line to the Ohio River, the reports will be vindicated, and the Ohio system will assume much more simplicity. At present it can only be said that one coal seam has been traced with certainty through the series, and that is the *Pittsburgh, Wheeling, and Pomeroy bed*, above the so-called barren measures.

Using this as the only well-fixed horizon, there are below it, as represented in the above table, in Columbiana and Jefferson counties ten (10) seams of coal and six (6) of limestone. In the Conotton Valley, according to Prof. Read, there are seven (7) beds of limestone, and seven (7) of coal. In Muskingum county eight (8) seams of coal, and twelve (12) of limestone. Further south, at Hocking and Athens counties, different observers do not agree as to the number of limestone, iron ore, and coal strata. There are profiles showing eleven (11) beds of limestone, and seven (7) seams of coal. In Gallia and Lawrence counties, on the Ohio River, Messrs. Andrews and Gilbert give in the same vertical space, seven (7) beds of limestone, and ten (10) of coal.

On the waters of the Tuscarawas, in the county of Stark, the west half of Carroll, Tuscarawas, Wayne, and Coshocton, is a geological field, where the strata have many features in common, which may be recognized as far south in Licking and Muskingum counties as the Licking River and the National Road. Beyond this line in that direction, changes occur in

the number and the character of the beds, which renders it difficult to establish strict identity in the series.

In the other direction, on the waters of the Great and Little Beaver Rivers, and of Yellow Creek in the east half of Carroll, in Columbiana, Mahoning, and Trumbull counties, and over the line in Pennsylvania, there is also a manifest difference in the deposits, from those on the waters of the Tuscarawas. Notwithstanding these variations, Professor Newberry concludes, that coal seams Nos. 5 and 6 are continuous from the Pennsylvania line on the east, through the summits between the waters of the Beaver and the Tuscarawas Rivers, to Zoar, Trenton, Coshocton, Zanesville, New Lexington, and Straitsville.

Coal seam No. 1 has been traced from the valley of the Mahoning, on the east line of the State, along its outcrop through Portage, Summit, Stark, Wayne, and Holmes counties.

No. 1 coal beneath these very regular beds, is very irregular of deposition. It consists of a series of hollows and ridges, sometimes connected and at others isolated, the rims of which are thirty to fifty feet above the bottom. In the coal seams above the lower lime-rock group, the same irregularity may be seen. Coal seams Nos. 5 and 6, and the associated rocks on Yellow Creek, vary in level eighty and one hundred feet in a mile. At Morgan Run, near Coshocton, there are waves in the upper seams like those at Massillon and Niles in the lower ones.

No. 3, or the lower limestone coal seam, is readily traced from the Mahoning Valley westerly, lying about one hundred and sixty feet above No. 1, as far to the west and south-west as Sugar Creek Valley, in the north-western part of Tuscarawas county.

ELEVATIONS OF POINTS IN THE LIMESTONE GROUP.

| Places of observation. | Elevations above Lake Erie. | | | Vertical space of the group. |
|------------------------|-----------------------------|--------------------------|-------------------------|------------------------------|
| | Lower limestone, No. 1. | Middle limestone, No. 2. | Upper limestone, No. 3. | |
| Poland | 340(?) | 365(?) | 425(?) | 85(?) |
| New Lisbon | 290 | Not given. | 485 | 195 |
| Navarre | 452 | 477 | 565 | 113 |
| Bolivar | 386 | 422 | 450 | 64 |
| Agnus Hill | 370 | 476 | 557 | 187 |
| Avondale | 316 | 351 | 384 | 68 |
| Zoar | 300 | 370 | Not seen. | Not seen. |
| Magnolia | 336 | 376 | 416 | 80 |

From the Mahoning westerly to the heads of "Big Sandy," near Hanover Station, only a short space below No. 6 coal, is a bed of lime rock,

designated as the "white limestone." This is not to be confounded with the white lime rock above the so-called No. 7 coal, on Yellow Creek.

The connecting link between the Tuscarawas Valley series and that of Little Beaver, is the lime rocks Nos. 1 and 2, over the so-called coals Nos. 3 and 4. Above these beds the strata are far from regular or persistent, requiring further and closer examination.

The profiles made by Prof. Stevenson, near Magnolia, in the north-west corner of Carroll county—by Prof. Newberry, at Mineral Point and Zoar Station, near the north-east corner of Tuscarawas county—by myself, from Bolivar to Massillon, in Stark county, and by Prof. Andrews, in Sugar Creek valley, near the forks at Deardorf's Mill, are so diverse, that they cannot as yet be made to fit each other. (See Figures 1 and 2.)

The great puzzle of our system is, to determine where those beds which are lost, terminate, and where those which are nearly on the same horizon, come in. Nothing but exact physical work can determine those points, and in many parts of the field such work is yet wanting. If the strata taper out on the line of their strike, they must also taper out on the direction of their dip, and therefore, in some instances, exist only as local patches. This feature of the Ohio series renders it one exceptionally difficult to survey.

I find in the reports frequent allusions to the completeness and value of this survey. Here, in the midst of the series, is an area of at least five townships, occupying a valley twenty miles in length, embracing all the beds of the lower coal strata, open to inspection in hundreds of places, with all the materials for making iron in abundance. The valuable information which the public may extract from all the reports relating to this region, might have been acquired by an active explorer in one day.

The officers of the C., C., C. & S. Railroad Co. found so little had been done in this region, that it was necessary for the company to make a detailed survey for itself. Prof. Andrews, in the prosecution of this work, with the assistance of Mr. H. D. Dennis, and of W. Jones, the engineer, was unable to connect these beds with those of the valley of the Kilbuck on the west, or of the Tuscarawas on the east. An undiscovered horizon of blackband ore was brought to light by him, and a bed of coal, not noticed by the Survey. For these reasons, it becomes necessary to give something more than a general notice of this important mineral region. The sandstones are not a reliable guide in determining the equivalency of strata; in truth, the more complete and exact our explorations become, the more numerous and more perplexing these irregularities appear.

Until the third limestone was discovered by Prof. Andrews, in the

Sugar Creek valley, it did not seem possible that No. 6 could be persistent. By extending the white limestone of Columbiana county—the first one below No. 6 coal—to the westward, through Tuscarawas, the position of the report is strengthened. On that basis the place of No. 4 coal and No. 2, or the “Putnam Hill limestone,” must be changed in several of the sections.

The Zoar section, which is a typical one for this region, and to which the lower coal series of the State has been forced to conform, does not show this lime-rock. (See profile No. 2.) Until it was observed in the Sugar Creek valley, I did not feel sure of its existence west of Hanover, in Columbiana county, although there are fragments of it in the drift of Suffield, in Portage county. It is only for convenience and provisionally that the terms *blue*, *gray*, and *white* are applied to the lower, middle, and upper limestones. All of them are, in places, blue; all of them have coal beneath, and, generally, a show of iron ore above.

Large quantities of shell and block ore have been mined, resting upon No. 2, or the “gray limestone” of the reports. This has also been confounded with the white or No. 3. Its existence there, though unfortunate for the typical section of the State, sustains the theory of the report in regard to the general persistence of No. 6 coal seam. The Putnam Hill limestone is, however, thrown out of place in several cases by the better establishment of this coal.

Where this is made typical among the limestone beds, by Prof. Andrews, it is the first regular bed below Coals Nos. 5 and 6, between which there are no lime strata in that part of the State.

Using the physical sections of Mr. Jones, I connect this bed with the upper one at Rowville, 480' A., and 71 feet below No. 6 coal, rising to the northward as far as Fisher's coal mine, where it is 538" A. The lower limestone coal at Avondale thus becomes No. 1 of the Ohio series, over No. 3 coal, and the middle one No. 3a. Above this, No. 3b coal is wanting here. The bed of flint on this profile next below No. 5 coal is probably local. In the valley of White Eyes Creek, according to Prof. Andrews, the Avondale profile holds good, with little variation.

No. 4, of the report of 1870, is now regarded as No. 3a. No. 4 proper, is the second, or “gray limestone” seam, a companion of No. 1, in both of which there is a lime-rock roof. From the valley of the Mahoning to that of the Tuscarawas, near Massillon, they are only twenty-five to thirty feet apart, very regular and conformable. The lime beds being the result of an action not merely sedimentary, but, like the iron ores, also of chemical segregation, in quiet waters will form in more perfect planes than the shale, sand-rock, and coal strata.

On the west side of the south fork of Sugar Creek is the usual bed of sand-rock over Coal No. 6. On the east side of the same valley it is principally wanting, replaced by shale, in which are important beds of iron ore. Such irregularities in our deposits perplex the explorer, but should not surprise him, for this is one of the most uniform characters of the Ohio series. This fact should make him very cautious in deciding upon equivalents.

The Deardorff sandstone overlying No. 3 coal, and its lime-rock, is easily traced from Justus Station to Beach City and Agnus Hill, and thence on both sides of the valley to school-house No. 7. Neither the Deardorff sandstone, the limerock just above it, nor the coal bed a few feet higher, fall into proper relations with the beds named in the survey.

The lime-rock, 38 feet above the Fisher coal, 538 feet above Lake Erie, is at the Shetlar mine, near Navarre, 542 feet, and 36 feet below Coal No. 5. Here No. 6 is 42 feet higher, overlaid by sandstone to the top of the hill, 30 to 40 feet thick. At Agnus Hill No. 5 is worked at an elevation of 575 feet. At Shetlar's it is heavier than No. 6.

The Fisher bank, Weimar's, lower Agnus, Schrock's, and Nead's banks, with those in the same horizon, for convenience of description I have called No. 3*b*. This coal is very regular in thickness, 3 to 3½ feet, easily wrought, lies above drainage, and is of mercantile value. As a part of the geological series, it must be regarded as local, covering a comparatively small field. South of the summit it has not yet been found. It is highly probable, however, that the lime-rock No. 2 in the Avondale profile of Prof. Andrews is the same that crops out on Sugar Creek, 10 to 20 feet below this coal. Here there is a coal bed underlying it, which I have called No 3*a*.

On the west side of the valley No. 6 is well defined, from Wilmot to Shoup and Baker's mine, overlaid everywhere by a heavy sand-rock, 40 to 60 feet in thickness, forming the surface of a high ridge, 640 to 660 feet above Lake Erie. It is 3½ to 5 feet thick, and has a very strong heating power. Following it southerly to Shanesville, Harman's, and Farmersville, it becomes more dry burning, and is a very bright black and handsome coal. No. 5 in this direction becomes less regular but is workable in several places.

In profile No. 4 I have represented the general structure of this region. Beds within two miles of the general course of the profile are projected on a vertical plane, which is placed near the line of the Tuscarawas Valley and the Beach City and the Coshocton Railways. It represents three beds of coal, and in places four, having a workable thickness. In no place is there less than one, and in many places *three* beds of limestone

above drainage. The iron ores are not represented. Along the highlands between Sugar Creek and the Tuscarawas, ore has been uncovered at numerous points from Navarre to Strasburg, principally over No. 2 limestone and No. 5 coal. These ore seams appear on both sides of the south fork of Sugar Creek, as far as Rowville, and some of the hills are high enough for those over No. 7 coal.

The above table of elevations in the limestone group shows that the railway route from Canton, by Beach City to Rowville, is nearly on the line of bearing of the strata where they are approximately level. Limestone No. 3, at Navarre, is 566, a mile east of Beach City 536, Agnus Hill, 551, Shanesville, 486, Rowville, 480. I have calculated the local dip of all the beds in the vicinity of this line, and find it to be south-easterly, but very slight, 12 to 15 feet per mile. The lower limestone, or No. 1, on a line due south from Greentown to Zoar, a distance of 25 miles, sinks from 455 to 300 feet, or 155 feet. From Rowville south the beds dip more rapidly. No. 6 coal, which is here 551, is at Avondale 447, a difference of 104 feet in five miles.

At Coshocton it is not well settled which of the beds is No. 6. At Trenton, 15 miles south, 70° east from Rowville, it is 336 feet, making a descent of 215 feet, equal to $14\frac{1}{2}$ feet per mile. Over small spaces, when the local undulations are considered, the beds for mining purposes may be regarded as level, the best points for making entries to be determined by survey of each location. Here the number of seams of coal in the lower series is *nine*, but of these only *four* are of merchantable value.

CLEVELAND, OHIO, *November 1, 1878.*



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